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PSYCHOLOGY AS A CAREER[1]

PSYCHOLOGY is the science which deals with the nature of human and animal behavior and with the direction of its forces from the point of view of mental life.

There are as many words in the dictionary with mental connotation as with physical. There are as many mental phenomena subject to scientific study as material phenomena. The mental sciences may in the near future have as many branches and embrace as large scope as the material sciences.

As out of the pure physical sciences have come engineering, medicine, architecture, and other forms of applied material sciences, so in the near future will come the applications of psychology to education, medicine, industry, art, and all other varieties of human endeavor in which scientific knowledge of human or animal behavior can be made of practical value.

The opportunities for a career in mental science will, in the near future, be as numerous as in the material sciences.

No science is more intimately and practically related to the conduct of human life than is psychology. It is, indeed, concerned primarily with those facts and principles of experience and action upon which our understanding of ourselves as conscious beings and our ability to understand and sympathize with our fellows depend.

PURE PSYCHOLOGY

As now taught in the best colleges and universities, psychology is presented in several fairly differentiated courses. Ordinarily there is one general introductory course of one year furnishing a general survey of the subject from

[1] This article is one in a series published from the various divisions in the National Research Council under the general topic, "Opportunities for a Career in Science."

varied points of view. Beyond this, specialized courses are offered.

Technical laboratory courses in experimental psychology furnish training in the fundamental principles of scientific procedure in observation, measurement, statistics, interpretation and formulation of the laws of mental phenomena. This course furnishes a technique which should be employed in all branches of psychology regarded as scientific or experimental.

Physiological psychology usually reviews the facts about the nervous system as taught in neurology for the purpose of tracing the physical basis of mental life and showing the relation between the mental and the neural.

Genetic psychology is divided into two parts; mental evolution dealing with the training and development of mental life in the species, and mental development dealing with the unfolding of mental life and the integration of behavior in the life of the individual. Within this field lies also the problem of the inheritance of mental traits.

Abnormal psychology deals with mental phenomena that are strange and irregular deviations from the normal but not strictly regarded as disease; such as hypnotism, mediumship, and alterations of personality.

Animal psychology presents a field of great interest in itself; but it is of special significance in that it throws light upon human life, particularly in the study of the simplest and the highest forms of animal behavior.

Social psychology treats of the social aspects of mental life and often blends into other subjects, such as anthropology, social origins, social ethics, social welfare, and eugenics. Sometimes race psychology, or the psychology of peoples, is differentiated from social psychology.

Individual psychology is perhaps the most conspicuous field of interest at the present time as it is the foundation for "human engineering" in all its forms of selection and guidance of individuals as well as for an intimate and accurate account of character or individuality of a person. It has recently gained great impetus through the development of so-called mental tests.

Statistical psychology is a basic requirement for mental measurement, particularly as employed in mental and physical testing and in psychology applied to education, commerce, sociology, and vital statistics.

Psycho-analysis has come in from the medical side as a unique and new approach to the study of mental disorders such as hysteria, morbid fear, aversions, and suppressed desires; but also throws much light upon the nature of normal mental life. This is yet a polemic field in which we find great enthusiasms and antagonisms in contest.

Behaviorism is a purely objective study of human and animal life without reference to the testimony of consciousness.

These items may suffice to indicate roughly the principal points of view that the student entering upon a career in psychology must acquaint himself with as each contributes a distinct element to the conception of psychology as a whole.

Applied Psychology

Psychiatry, as the science and art of the treatment of mental diseases, is the only fully specialized profession which may be regarded as applied psychology, although in many respects it has developed independently and has contributed much to normal psychology. But aside from psychiatry proper, there are many specialties in medicine in which expert knowledge of the human mind and behavior is fundamental; as in the care and treatment of children, and the mental treatment of all types of defectives and delinquents. Preventive medicine, public health education, and sanitation are built largely around psychology as the science of human behavior.

Educational psychology presents numerous phases. Thus we have the psychology of the course of study, of the child, of the adolescent, of the learning process, of discipline, of particular types of training, and of special classes. The science and art of education is primarily applied psychology.

The psychology of business and industry appears in several large and distinct fields; such as the psychology of advertising, of salesmanship, of personnel, and of vocational selection and various types of efficiency activities.

Legal psychology appears in two groups of interest; first, the psychology of evidence or testimony and pleading; and second, the psychology of crime, delinquency, defective mentality, penology, dependency, correction, and special types of mental deviation.

Applied social psychology takes such forms as the psychology of social amelioration, eugenics, race betterment, child welfare, community welfare, recreation and amusement, and vocational and avocational guidance.

The psychology of art appears in the psychology of music, of graphic and plastic arts, and of literature, dealing in each case with the psychology of art principles, the psychology of the individual, and the psychology of training for the art.

The psychology of religion is applied mainly in the interpretation of religion and religious life, and in the organization of character building and religious education.

The above rubrics should not be regarded as an adequate classification of the fields of pure and applied psychology; they are listed merely as a suggestion for the purpose of showing the scope of the sciences and the types of outlets for a career.

FITNESS FOR A CAREER IN PSYCHOLOGY

The requirements for a career in psychology are in general the same as for other sciences; and psychology presents a wide range of outlets through particular types of human interest. In determining whether or not the student is qualified for a career in science, he might make use of a little device in applied psychology as illustrated in the following rating scale:

ANALYZED RATING OF FITNESS FOR A SCIENTIFIC CAREER

1. Reasoning power: capacity for solving problems, both deductive and inductive.
2. Originality: creative imagination, brilliancy, planful initiative and fertility of rational ideas.
3. Memory: extensive, logical, serviceable, and ready command of facts.
4. Alertness: quick, incisive, and responsive observation, thought and feeling.
5. Accuracy: precise, keen, regular and reliable observation, thought and feeling.
6. Application: power of concentration, sustained attention, persistence, and well-regulated effort.
7. Cooperation: capacity for intellectual companionship, team work and leadership.
8. Moral attitude: intellectual honesty, wholesome moral standards, ideals and influences.
9. Health: nervous stability, physique, vitality, and endurance.
10. Zeal for investigation: deep interest in and craving for original and creative work.

Let the student rate himself and then ask three or more persons whom he regards as most competent and who know him well to rate him independently. Record the rating on a scale of 1-100 in which 1 represents the poorest example of this trait, and 100 the best that the person rating has ever observed in *college students*. College students, as a selected class, then become the "measuring scale."

These grades may be grouped as follows: 1 to 10 very poor; 11 to 30 poor; 31 to 50 low average; 51 to 70 high average; 71 to 90 excellent; and 91 to 100 superior.

These ratings will differ, but the very differences may throw significant light on the situation. For example, on "originality" the professor of literature may rate an individual low on the basis of observed work in poetry; whereas the chemist may rate him high on the basis of observed work in science. These represent two types of originality; or one person rating may have encountered the flashy fertility of ideas, whereas another may have observed a planful and persistent initiative, both of which represent originality, but of different types. For this reason the ratings on a given trait should not be averaged but analyzed. The student should seek a full and frank discussion of the grounds for each rating as this will analyze the situation further and throw important light on the nature of his character and capacities.

Nor should the ratings on the ten points ever be averaged. A man may be very high in one capacity and low in another and such differences are significant; but an average of them would be misleading. No person is uniformly high or low in all. These traits are not of equal value; some traits are more essential for one type of career than for another.

In general we may say that those persons who rank above 50 in the most essential traits give promise of achievement in a career in psychology.

Natural interest is another factor of which we should take account. A student seeking a career in psychology may have the opportunity of following his natural bent for interest in pure science or its applications to the educational, social, ethical, medical, artistic, and other fields of human interest in which he may find his natural bent.

TRAINING

The study of psychology is usually begun in the second year in college; whereas many other subjects are begun in the high school or in the freshman year. As a result, it usually becomes a more advanced subject and there is more necessity for carrying it into graduate study. Most standard colleges and universities now offer good introductory courses in the subject, but beyond the elementary work, the student should seek institutions in which the particular phase of psychology that he desires to pursue is most adequately represented. The best is none too good for one who desires to specialize. In selecting, let the student choose, not on the basis of size of institution, but with reference to the men who are recognized as most worth while in a particular specialty.

As a prerequisite to a career in psychology, it is desirable that one should have command of French and German as a large portion of the literature on the subject is in these languages. He should also have pursued elementary courses in mathematics, biology, and physics. Other college subjects may be carried to advantage with, or in sequence to, an elementary course in psychology.

There is now a movement on foot to provide for the certification of psychologists. Such certification will be based on certain types of courses, usually covering about three years of graduate work, and will entitle the psychologist to practice within his field of specialization. Legislation covering such licensing is now being passed by dfferent states.

Psychology is a new science. In seeking advice, only those who are conversant with current literature and present movements in the subject should be consulted.

TYPES OF CAREER

There are at present four distinct types of outlet:

Teachers of Psychology—The nature of this work and its opportunities are perhaps best known.

Scientific Research—The coming in of experimental psychology has opened up most fascinating new fields of investigation and many agencies furnish opportunity for a career as original investigator. The leading universities usually encourage this in connection with some teaching; but there are opportunities in universities, scientific foundations, surveys, and privately supported enterprises for persons who are unusually qualified for this type of work.

Specialists and Consulting Psychologists—Here the opportunities are most varied and new fields are opening rapidly as a result of research in each of the branches of applied psychology.

Technicians—All the specialists require technicians of various kinds as assistants. Most of these positions are, however, used as stepping-stones or apprenticeships in the gaining of experience for independent work.

Highly qualified advanced students can often find scholarships, fellowships, assistantships, and other financial provisions, given theoretically in recognition of some type of apprenticeship to graduate students. The remunerations open to persons who seek a career in psychology vary so much that figures would not be significant. In general, they depend upon the natural ability, the degree of training, and successful specialization.

C. E. SEASHORE.
DIVISION OF ANTHROPOLOGY AND PSYCHOLOGY,
NATIONAL RESEARCH COUNCIL

HORTICULTURE AS A SCIENCE[1]

LIKE most applied sciences, horticulture has evolved by very slow degrees from an art, governed by rules justified by experience, to a

[1] Read before the Association of Southern Agritultural Workers, Atlanta, Georgia, February 21, 1922

science based on laws or principles of universal applicability. The term "applied science" would seem to connote that these laws or principles are ascertained first and that they are then applied to specific conditions, but as a rule the applications are known and are practiced, having been hit upon by empirical means and the first function of an applied science is usually to "explain" them by discovering the principles involved. When a considerable number of principles have become established in this way, new applications for them are found and the applied science becomes in effect what its name implies.

A large part of the experimental work in horticulture has been conducted with the object of devising new rules and of ascertaining new facts of an empirical nature. More recently, however, considerable effort has been made to find principles of more or less universal applicability and this has been accomplished by a study of the fundamental factors determining plant growth and productivity. Though many valuable practices have not yet received scientific elucidation and though much good work remains to be done in the way of discovering new rules, a large body of well established principles has been accumulated and successful practice depends to an ever increasing degree on their recognition.

A comprehensive investigation of almost any horticultural problem involves much the same succession of stages as has been outlined for the development of the science; (1) The field for investigation is usually explored by experimental work of an empirical nature. (2) This is followed by scientific study to determine laws or principles. (3) This in turn is followed by more experimentation to test the feasibility of applying to particular conditions the principles that have been discovered. It seems customary to extol the scientific study which aims to formulate laws and to dignify it by some such appellation as "fundamental research." By implication, the attendant phases of investigation seem to be deprecated on the ground that they are largely empirical. However, this invidious distinction is unwarranted, as every investigator learns sooner or later, for these three aspects of investigation are like three links in a chain and progress in horticulture depends on their parallel development. Principles are of little value to the horticulturist if they cannot be applied, just as a collection of experimental data is of small import until it receives interpretation.

The strictly scientific aspect of horticulture is closely allied to botany and it is difficult to state wherein the distinction between the two lies. It is largely a difference in emphasis, since the horticulturist is interested only in those phases of botany that may be applied to his specific purposes. Nevertheless, the development of horticulture has followed closely in the steps of botany. During the last century the attention of most botanists was directed to morphology and taxonomy, a tendency reflected in the advances made by horticulturists in the subject of pollination and fruit setting and in the development and description of varieties. At present these subjects are better rounded and more nearly complete in their major aspects than almost any other phase of horticulture. Now that plant physiology is in ascendency, more rapid progress is seen in the nutritional problems of horticulture—in fruit bud differentiation, in pruning and in fertilizer treatments.

The dependence of horticultural science not only on botany but on other sciences as well may be illustrated by reference to recent work on the so-called Hardiness Problem. Although this has engaged the attention of both horticulturists and botanists for many years, until lately little was accomplished other than a substantial verification of the Laws of Temperature formulated by De Candolle nearly a century ago. Investigators were still faced with the seemingly contradictory facts that death from low temperature is due to loss of water from the cells by ice formation in the intercellular spaces and that nevertheless hardy plants usually contain less water than tender plants. What seems to be a satisfactory solution of this problem was made possible by some chemical investigations of Foote and Saxton at Yale University. This work showed that water may exist in different forms, and that

the water held by colloids possesses properties different from those of "free water," particularly with regard to the temperature at which it freezes. This work suggested to Bouyoucos of the Michigan Agricultural College a classification of soil water into "free" water, which freezes at 0° C. or slightly below, colloidally adsorbed water which freezes at temperatures from a few degrees below zero down to -78°C., and combined water, which freezes only at temperatures below -78°C. This classification was applied by McCool and Millar to the water of plant tissues. The work of these investigators suggested an explanation of the greater tenderness of plant tissue with the higher water content. If hardiness depended not on the total water content, but on the content of colloidally adsorbed water which does not freeze at ordinary freezing temperatures, then a plant tissue might contain any amount of free water and still be tender, while a relatively small amount of water in the adsorbed condition would impart a considerable degree of hardiness. Recent investigations at the University of Missouri have shown that these surmises are correct, at least for some plants.

If hardiness depends on the amount of colloidally adsorbed water, what colloid holds it in this adsorbed state? Some botanical investigations by Spoehr of the Carnegie Institute suggested the probable answer to this question. He found that in cacti water-retaining capacity is correlated with pentosan content and that when the water-retaining capacity is increased or decreased by changes in environmental conditions, the pentosan content likewise increases or decreases at the same time. Pentosans were therefore investigated in fruit plants and vegetables and a correlation was found between pentosan content and hardiness. This correlation is remarkably close if hot water soluble pentosans only are considered. These findings indicate that certain pentosans, probably pectin-like substances, are the colloids that hold water in an adsorbed state. This is further substantiated by the fact recorded by Spoehr that dryness tends to increase the pentosan content of cacti and likewise their water retaining capacity. It is well known that cultural practices or climatic conditions that tend to dry fruit plants out in the fall, increase maturity and hardiness. Consequently the very conditions that lead to a low total moisture content probably increase the amount of water-holding colloids and the quantity of colloidally adsorbed water—hence the greater hardiness of plant tissues with the lower moisture content.

This understanding of the conditions associated with hardiness in plant tissues permits accurate outlining of the treatment or treatments that decrease susceptibility to low temperatures. It makes possible also an estimate of the magnitude of the effects that may be produced in that direction, and a recognition of their limitations. Such practices thus become incorporated in scientific horticulture.

This example indicates the intimate relation between progress in horticulture and progress in other sciences. Subjects which on superficial consideration might never be suspected of contributing data valuable for the solution of horticultural problems are seen to be worthy of study. If little headway has been made along certain paths of investigation, it is not infrequently because the methods, the facts or the technique essential to the solution of specific problems has been lacking. To this day, the official method for the determination of starch recommended by the Association of Official Agricultural Chemists is not an analysis for starch but for total hydrolyzable polysaccharides. Furthermore it is only within a comparatively few years that a satisfactory method for determining total sulphur content has been available. As a result, much painstaking labor has gone for naught, though some have noted, but have been at a loss to account for, the discrepancy between the results of such determinations and the unmistakable evidence of microchemical findings. The investigator can well afford to acquaint himself with recent advances in other fields and the broader his fund of information the more successful he will be. It might be suggested that progress in Physics, Meteorology and Forestry should be watched as well as that in various branches of Botany, in Chemistry, Soil Science and Agronomy. This task which would have been

out of the question a few years ago is greatly facilitated now by the increasing number of abstract journals and substantial help is afforded investigators in many institutions by Plant Science Seminars, Scientific Societies and the like. Even though such conveniences be lacking much can be gained by personal contact with investigators in other fields and by a mutual exchange of criticisms and suggestions.

Treatment — that is, orchard practice, whether it be pruning, irrigation, fertilizing, thinning or what not—is an aspect of horticulture that may be compared to medicine, and the comparison is instructive because it indicates a possibility of development in horticulture from the application of scientific methods used by the physician or surgeon. Cultivation, pruning, the use of fertilizers and other treatments have been considered only in the light of one standard, the effect on crop production. The limitations of this one-tracked system may be demonstrated by reference to some recent experiments on fertilizer treatments.

If apple trees are bearing poor crops, a spring application of some quickly available nitrogenous fertilizer will frequently increase the yield. Such increases are very striking on weak trees, but some results obtained at Missouri show they can be obtained also on trees in good condition—on trees that are already bearing fair or even good crops. This effect of quickly available nitrogenous fertilizers applied a couple of weeks before blossoming has been shown to be produced by increasing the set of fruit. Fruit setting, however, is only one step in fruit formation. The process begins with the formation of fruiting wood and involves in succession fruit bud differentiation, bud development to the time of blossoming, pollination, fruit setting and finally fruit development. The failure or limitation of a crop may be occasioned by interference with any one of these successive processes. It would make little difference how favorable conditions might be for fruit setting, if fruit bud differentiation had not occurred. Recent investigations have shown that those conditions in apple trees, produced by spring applications of quickly available nitrogenous fertilizers, which are so favorable to fruit setting, do not favor fruit bud differentiation. Hence if poor crops result from deficiency in the initiation of fruit buds, spring applications of quickly available nitrogen would only accentuate the trouble.

This work reopens for investigation the entire orchard fertilizer problem which was thought by many to have been solved in the last few years by experimental work with sodium nitrate in the orchard. The same kind of fruit tree may present many different nutritional problems for treatment. Each problem requires special study and the remedy in horticulture, as in medicine, depends on accurate *diagnosis*. The use of fertilizers to correct the alternate bearing habit in apple trees constitutes a problem as distinct from their use in increasing the set of fruit as spraying peaches for San Jose scale is from spraying to control scab. As investigators, we are too ready to dispose of problems by assuming that either the nutrition, the moisture or the temperature relations are involved and that cultivation or the application of some fertilizer will lead to maximum growth and productivity. We would spare ourselves the effort of analyzing the problem—of making a diagnosis to determine the precise difficulty to be overcome. The time is not far distant when fertilizer treatments alone will be as numerous and as specific as all the horticultural practices recognized today. We must dispense with the idea of a mass attack on a bulk problem and apply more detailed methods, if we are to make rapid progress. Aside from technical improvements in such fields as spraying and marketing, the lines of pomological investigation along which greatest progress seems possible are treatment, propagation and plant improvement and treatment according to diagnosis promises to be one of the most fruitful.

There is no cure-all, no patent remedy for promoting growth, for inducing hardiness or for increasing crops. These can be accomplished only by careful study and hard work. No practice can be recommended for all circumstances or for all fruit plants, nor can the same practice be guaranteed to produce the same effects under different conditions. Treat-

ment should be regarded not so much in terms of practice as in relation to the specific physiological processes to be affected. Much work must be done before specific measures to influence these different processes in the desired direction are found. Many practices that have not proved generally efficacious in the past may be shown to have great value for specific conditions. Pomologists must think in terms of limiting factors, and not merely in terms of the soil elements that may limit plant growth but also in terms of the physiological processes that may be limiting fruit production. For all this work, an accurate knowledge of the chemical changes associated with different physiological processes is of the utmost value because a thorough understanding of the conditions desired may suggest means for their accomplishment.

HENRY D. HOOKER, JR.
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COLUMBIA, MO.

A SUGGESTION AS TO METHOD OF PUBLICATION OF SCIENTIFIC PAPERS

THE processes of scientific publication are admittedly in an unhealthy state. Various influences contribute to the acuteness of this condition, but it is likely that a time of stress has merely emphasized weaknesses inherent in the ordinary procedure for printing scientific papers. The "jammed" plight of the periodicals is slowing the vital current of new results. It becomes desirable to consider alternative methods of printing, perhaps better adapted to the present character of our needs. In this country and abroad several suggestions have already been offered; the most drastic of these has urged the publication of abstracts only, completed manuscripts to be deposited for reference in some central place—a scheme having so many unfavorable features as to merit little serious attention; it is not merely *results* we wish, but also some at least of the steps in their derivation.

I have in mind more especially the field of zoology. To-day this subject is specifically served by a fine group of journals, and by an "advance" bibliographic service of filing cards bearing author-abstracts. This system of publication is maintained through the cooperation of the Wistar Institute. These journals were founded some years ago, and each was designed to cover a particular group of zoological interests. They do not now correspond, in titles or in any individuality of contents, to major aspects of zoological development. Their fields of service overlap, sometimes to an embarrassing degree.

Investigators acquire separata of papers of particular concern to them. There is thus brought about a quite unnecessary duplication in the distribution of published work, and a proportionate waste of paper. Subscriptions for support of the journals are drawn from membership dues of the Zoological and Anatomical societies. Members therefore receive most or all of the journals, in this way accumulating a mass of unused, largely unusable, material; while still necessarily relying upon the convenient "reprint" for actual reference and use.

I believe that these difficulties may be obviated, and the course of publication simplified and expedited. With the hope of attracting discussion of this matter, I outline here a plan regarded as practicable and to the point. The foundation of new journals has little to recommend it; these are likely soon to suffer the fate of the older ones. Save in some special fields, the journal method of publication has become measurably antiquated.

The journals should be abolished. They do not represent rational subdivisions of zoological activity. There is no real reason why papers accepted for publication should be grouped to make up a "number." It is certainly more desirable that a paper be printed when it is ready for printing. If issued and originally distributed as a "separate," unnecessary duplication of distribution can readily be avoided. This plan requires some central agency, such as we now have, for handling the mechanical details of publication. Serial numbers could be assigned to papers as issued. An entire series might then be bound by libraries, though the more sensible way would

be to have them filed alphabetically by authors.

In some essentials this procedure is already followed by the *Archives de zoologie expérimental et général,* by the Royal Society in its *Transactions,* by the Museum of Comparative Zoology, and by the University of California *Publications.* My suggestion, however, involves an important additional element. Society subscriptions continuing as at present, it would be a simple matter to have each member receive a certain number of published papers, more or less equivalent in total bulk to the journals now obtained. But it would be possible for the subscriber to select, through the Advance Abstract Bibliographic Cards, those papers specifically desired. Additional papers, not regularly obtained in this way or from the authors, could then be purchased at small extra outlay. The American Anatomical Memoirs and the few special reprints issued by the Wistar Institute have made a beginning in this direction.

The actual working of this plan would perhaps require that at, say quarterly, intervals there be issued Bibliographic Cards carrying the serial numbers assigned to the individual papers about to be printed. An accompanying order blank, by which articles desired could be requested by number, would give a simple, quick method of indicating one's needs. It would at the same time serve to show the printer the size of the issue to be prepared, after allowance had been made for reserve stock and for blanket subscriptions. The three-months' period mentioned is sufficiently long. The experience of the *Journal of General Physiology* shows that with efficient management it is possible to print accepted articles within less than that time, even under present conditions.

Authors should by this scheme be in some degree relieved from the expense of purchasing separata for extensive private distribution. One's library shelves, moreover, would no longer be encumbered with journal numbers which must be bound at ruinous expense or else remain unsightly.

Any working plan of this type must be conceived as applying chiefly to contributions of the character and average length now appearing in the journals. Incidentally, this scheme may show the way out of the difficulties sometimes made in connection with the rather arbitrary rule now enforced by the journals as to the maximal length of acceptable contributions. Although sometimes abrogated for reasons obscure, it has tended to be avoided by authors splitting the material of an essentially unitary piece of work into a number of articles. While the length rule has perhaps acted to restrain some wordiness, it is hardly a rational rule; one could wish it supplanted by editorial persuasion!

It may be suspected, as a conceivable result of the plan outlined, that the quality of the papers might be automatically improved. A paper which from the first is to "stand alone," rather than be supported fore and aft by comfortable neighbors, is likely to be more carefully written, perhaps even more carefully thought out.

There will remain, however, distinct and obvious need for the continuance of the journal form for the publication of short notes; perhaps also for periodicals in which the general results of investigation may be summarized and discussed; and certainly for at least one periodical such as the *Proceedings of the National Academy of Sciences.* It is my belief that under the operation of the plan I have suggested such journals would have a distinctly higher value than at present.

W. J. CROZIER

ZOOLOGICAL LABORATORY,
RUTGERS COLLEGE

CHARLES W. WAIDNER

DR. CHARLES W. WAIDNER, chief physicist and head of the Division of Heat and Thermometry of the Bureau of Standards, who died on March 10, 1922, is the fourth leader this bureau has lost by death since last May. The others are E. B. Rosa, chief of the Electrical Division; L. A. Fischer, chief of Division of Weights and Measures, and S. S. Voorhees, engineer-chemist. Waidner, Rosa and Fischer were of the original group gathered together in 1901 at the time the Bureau of Standards

was founded, and to its development each devoted his life.

Born on a farm in the suburbs of Baltimore, March 6, 1873, Waidner received his early training in the public and private schools of that city. He attended Johns Hopkins University where he graduated in 1896, and continuing in the graduate school, in which he was a pupil of Rowland, he received the degree of Ph. D. in physics in 1898. The subject of his thesis, "A comparison of mercury and resistence thermometers and an adjustment of Rowland's value of the mechanical equivalent of heat," in collaboration with F. Mallory, is the one to which Waidner devoted practically his entire professional career, namely, the determination of fundamental constants and standards relating to heat, and he became the first authority in the country on thermometry and heat measurements.

He served as instructor in physics at the Hopkins and also at Williams College, going to the Bureau of Standards on August 1, 1901, one month after its establishment. In 1903, he organized the Division of Heat and Thermometry, of which he was appointed chief, a position which he held until his death. It is characteristic of him to note that the first books he ordered at the bureau were a set of Regnault's works.

It is perhaps not without interest to recall the chaotic state existing in 1901 in this country with respect to thermometric data. Clinical thermometers were being certified to a scale one-tenth degree in error; manufacturers of thermometric instruments of precision each had his own "standards," usually of nebulous or ambiguous origin; for pyrometric data, one had to go to Germany; the temperature scale in the fundamental range 0° to 100°C of the International Bureau was available with difficulty and delay through French-made thermometers; there was practically no national or international agreement relating to heat measurements.

Waidner took up and successfully solved, in collaboration with his associates, each of these problems. Starting with the scale and methods of testing of clinical thermometers, calorimetric thermometry and the substitution of the electrical resistance method as standard in this range as for a portion of the higher and lower temperature ranges, this work included also exhaustive studies of the limitations of mercury-in-glass thermometers, and the introduction and development of optical and thermoelectric methods in pyrometric measurements. In the course of this work it was necessary to devise many new designs of apparatus and Waidner was exceptionally skillful in this field, and his designs have been used as models by many others.

He also saw the necessity of improving calorimetric methods to secure greater precision and his work, for example, on methods of measuring heating values of gases is recognized as fundamental for gas testing. He was responsible for the establishment of the distribution of materials of determined calorific value for calorimetric standards on which the testing of fuels depends; and also of pyrometric material standards of certified melting point, permitting the calibration of pyrometers by the user.

The investigations carried out by him or under his supervision on high temperature measurments were started when the subject was comparatively unknown in this country. This work provided pyrometric standards and methods of control for American manufacturers of pyrometers, and was of fundamental importance in the development of an industry which now finds application in many branches of manufacture.

As the bureau expanded, Waidner was able to devote less time to actual experimental work, but to the last was very active in the initiation and direction of the problems in heat, and many of the more recent papers from the bureau on such subjects, although they do not bear his name are nevertheless largely his product. During the past few years his interest centered mainly about several groups of engineering problems, one relating to the determination of constants of importance especially to the refrigerating industry; another concerned with the extensive investigations on the fire-resisting properties of structural materials; and a third, dealing with the methods of testing petroleum products.

During the war he had charge of the execution of many lines of research, including the elaborate work done by the bureau on aviation engines, the atmospheric conditions which are encountered at heights up to thirty thousand feet being produced for the first time in a specially designed altitude chamber. This work was of importance in many ways, such as in fixing specifications for gasoline for aviation engines, and determining their performance with variations in design.

His contributions to knowledge appear almost exclusively as a long series of papers in the scientific and technologic series of the Bureau of Standards. His work was most painstaking and thorough and was always thoughtfully planned and skillfully executed. He was a delightful and inspiring companion to work with, as I can testify from an almost daily association extending over twenty years.

Dr. Waidner was a man of wide acquaintance, a member of the Washington Academy of Sciences, the Philosophical Society of Washington, the Cosmos Club, the American Society for Testing Materials and a fellow of the American Physical Society and the American Association for the Advancement of Science.

In addition to his scientific position, Waidner naturally had at the bureau many important administrative and advisory functions to perform, some of them bringing him into close contact with his fellows. Thus, as a member of the editorial committee, continuously from its formation in 1903, he is largely responsible for the policy and standard of the bureau's publications. This position, as well as that of the chairman of the personnel committee, he filled with consummate tact and devoted conscientiousness. He had the saving grace of wit and common sense, and broke many a deadlock with a happy thrust that left no sting.

His associates will remember him not only for his high standard of work but for his ever ready kindly advice, some times given to good effect when not asked for, his sterling character, genial personality, intense loyalty to his friends and to the institution of which he was a dominating mind, and above all, during the past few years, for his grit and cheerfulness in combating the disease that finally took him off.

S. W. STRATTON
BUREAU OF STANDARDS

SCIENTIFIC EVENTS

VIENNA INSTITUTE FOR ICE AGE RESEARCH

SCARCELY any department of scientific research is of more general interest than that which concerns prehistoric man, his development during the Ice Age and the changes then taking place in the conformation of land and sea. Yet, with the exception of the Institute of Human Paleontology in Paris, generously endowed by Prince Albert of Monaco, there has hitherto been no special center for the investigation of this period.

A public institution for study of the Ice Age has now been established in Vienna in connection with the Natural History Museum of the Austrian Republic, and every effort will be made to investigate the phenomena of the Ice Age on a broad scientific basis.

The geographical position of Vienna renders it well adapted for this purpose, since the land structures associated with the glaciation can be studied in the vicinity and observed in their ancient relations to the environment of prehistoric man. Lower Austria is well known to have furnished a rich store of ancient stone implements and weapons.

The Vienna Institute is under the leadership of Dr. T. Bayer, director of the anthropological and ethnographical collections. Dr. Bayer's papers in which he demonstrates the existence of no more than two distinct periods of glacial conditions may be said to have created a new basis for this field of research. He is assisted by a group of colleagues and it is hoped to extend the circle of workers to include those in other countries who are devoting themselves to this period of research. They are invited to enter into communication with Dr. Bayer at the Natural History Museum, Vienna, who will be pleased to give fuller information as to the present activities of the institute.

JULIUS PIA
VIENNA, MARCH 16

THE ALL-RUSSIAN CONGRESS OF ZOOLOGISTS IN PETROGRAD

The first All-Russion Congress of Zoologists, Anatomists and Histologists is to be convened from April 23 to April 30 in Petrograd. At this congress it is expected to have the following sections: 1. Systematics, Zoogeography and Ecology; 2. Morphology (with Embryology); 3. Anatomy and Histology; 4. Experimental Zoology and Genetics. For the general sessions of the congress the following addresses will be delivered:

L. S. Berg: Polyphiletism and evolution.

A. S. Dogel: The causes which lead the living body to old age and death.

G. A. Kojevnikoff: Polymorphism and evolution.

N. K. Koltzoff: Eugenics, its problems and methods.

N. M. Koulagin: Zoology, science and agriculture.

M. M. Novikoff: Modern opinion regarding structure of chambers.

A. N. Severtzoff: The origin of fish and problems of phylogeny connected with this question.

P. P. Soushkin: The history of fauna of Siberia and Central Asia.

U. A. Philipchenko: The problem of experimental study of variations.

V. M. Shimkevich: About the regularity of the systematical indications.

V. M. Shimkevich is chairman and K. Derugin and V. Tonkoff are vice-chairmen.

ASSOCIATION OF GEOLOGISTS AND NATURALISTS IN PEKING AND VICINITY

THERE has recently been effected an informal association in Peking to bring together the geologists and naturalists resident in Peking and the vicinity for discussion of problems of mutual interest and the furtherance of intellectual intercourse among men of science in the Far East. Several meetings have been held at the residence of Dr. Roy Chapman Andrews at the headquarters of the Third Asiatic Expedition, at the residence of Dr. J. G. Anderson, at the Peking Hotel, in Central Park and elsewhere. The meetings are preceded by an informal dinner. On March 22 Dr. Walter Granger was expected to present the results of his recent expedition to the fossil fields of eastern Szechman province.

Those who have previously attended these meetings include:

Dr. V. K. Ting, honorary director of the Geological Survey of China.

Dr. W. H. Wong, director Geological Survey of China.

Dr. J. G. Andersson, mining adviser to the Chinese government.

Dr. E. E. Ahnert, director Geological Committee of the Russian Far East, Vladivostock.

Dr. Roy Chapman Andrews, director of the Third Asiatic Expedition.

Professor George B. Barbour, professor of geology, Pei Yang University, Tientsin.

Dr. Davidson Black, director of the department of anatomy, Peking Union Medical College.

Dr. Walter Granger, paleontologist to the Third Asiatic Expedition.

Dr. Otto Zdansky, associate paleontologist to the Geological Survey, China.

Professor Charles P. Berkey, geologist of the Third Asiatic Expedition.

Mr. Clifford Pope, assistant zoologist of the Third Asiatic Expedition.

Dr. F. R. Tegrengen, mining geologist.

Professor F. K. Morris, associate geologist of the Third Asiatic Expedition.

Dr. A. W. Grabau, paleontologist of the Geological Survey of China and professor of paleontology, National University, Peking.

Dr. Harry Smith, assistant professor of botany, Uppsala, botanist and explorer.

Père Licent, naturalist and explorer, Tientsin.

The gatherings are said to have proved highly stimulating. Frequent meetings during the winter and spring months are planned.

THE MENDEL CENTENNIAL

IN commemoration of the hundredth anniversary of the birth of Gregor Mendel, there will be held a scientific gathering in the city of Brünn, Czechoslovakia, from September 22 to 24. A *Festchrift* containing original contributions in the field of genetics will be published.

The secretary of the local committee, Professor Dr. Hugo Iltis, has asked me to call this celebration to the attention of American geneticists and to extend to them a cordial invitation to take part in the celebration in any or all of the following ways:

(1) By accepting membership on the International Committee: (2) by being present in person at the gathering in Brünn on the date mentioned; (3) by making a voluntary contribution toward the expenses of the gathering and of the *Festschrift;* and (4) by submitting a manuscript for publication in the memorial volume. Such MSS. should be sent to Professor Dr. Hugo Iltis, Bäkergasse 10, Brünn, Czechoslovakia, and should be in his hands by the end of May, 1922. Money contributions should be made payable to the Mendelfeier-Konto, Böhmische Eskompte-u. Kreditbank, Brünn. It is hoped that American geneticists will cooperate as fully as possible to make the celebration a success.

GEO. H. SHULL

COLLOID CHEMISTRY AT THE UNIVERSITY OF WISCONSIN

THE chemistry department of the University of Wisconsin announces that Professor The. Svedberg, of the University of Uppsala, will be in residence during the second semester of the scholastic year of 1922-23 and the summer session of 1923.

While at Wisconsin, Professor Svedberg will organize and direct the research work in colloid chemistry, and will also give two lectures each week on the subject and conduct two weekly seminaries. One seminary will be devoted to the broader aspects of colloid chemistry and the other to its biological applications.

Professor Svedberg is recognized as one of the international authorities on the subject of colloid chemistry. He is the author of many papers dealing with the fundamental principles of colloid chemistry and has written the best known treatises on the preparation of colloids. His work has been recognized by the award of numerous prizes and special research funds and he has been honored by numerous foreign societies.

During the summer session of 1923, lasting for a period of six weeks, the lectures given during the second semester will be repeated for the benefit of educators and research workers who find it impossible to attend the university during the regular session. A seminary will also be conducted throughout the summer session.

Advanced workers who desire to do work under the direction of Professor Svedberg should communicate with Professor J. H. Mathews, director of the course in chemistry, since only a limited number of research workers can be accommodated.

YALE UNIVERSITY AND DR. CHITTENDEN

AT the regular monthly meeting of the Yale Corporation, held on March 11, the following resolution was adopted in connection with the resignation of Dr. Chittenden as director of the Sheffield Scientific School, which takes effect at the close of the present university year:

Even in his undergraduate days in the Sheffield Scientific School Director Chittenden had begun to pave the way to a distinguished career as a teacher and investigator in physiological chemistry, for the development of which as an independent branch of study he has been responsible not only at Yale but in large measure in the United States. His was in many respects the path of a pioneer in a borderline science which inevitably led both at home and abroad to recognition and honors in which the institution that Director Chittenden served has shared abundantly.

Not less successful has been Dr. Chittenden's leadership as director of the Sheffield Scientific School for nearly a quarter of a century. His unflagging energy and broad vision have contributed largely to increase the material resources of the school, to enlarge the scope of its usefulness as an institution for professional training in science, and to stimulate and encourage investigation. The recognition at Yale of the important part which the study of science should play in modern education is due in no small degree to Dr. Chittenden's influence. Research at Yale has always found a staunch supporter and advocate in him.

To a man of Dr. Chittenden's training and ideals even the partial abandonment of the pursuit of science necessitated by the call to an executive post must have meant a personal sacrifice. He has accepted this, as he has undertaken many other public tasks, in a spirit of service which deserves grateful recognition on the part of Yale Universiy.

The Yale *Alumni Weekly* says in an editorial article:

The resolutions adopted on the resignation of Director Chittenden by the Yale Corporation place a richly merited emphasis on the character

of the service which the retiring administrative head of the Sheffield Scientific School has rendered since he succeeded Dr. George Jarvis Brush in 1898. The latter was the first incumbent of an office which offered unusually large opportunity to a man of energy and imagination. That Dr. Chittenden has taken advantage of the opportunity is strikingly demonstrated by a review of the development of the school under his far-seeing administration. This sympathetic interest has covered not alone his own special field of physiological chemistry, in which he as well as other members of the Scientific School faculty group have accomplished important results, but also other departments, including those in engineering. It is doubtful if any administrative officer of the university has ever followed more intimately the work of his office or brought to his task a more generous measure of loyal and intelligent effort. The qualities which distinguish the Scientific School and elevate it to the front ranks of institutions of its class must be attributed largely to the man who now quietly lays down duties which he has unremittingly carried on for almost a quarter of a century. Graduates of the university, whatever their school affiliations and interests, will unite in paying tribute to such a record of service. They will look for years to come for the results of the successive contributions of Director Brush and Director Chittenden and will certainly find those results in an ever more useful Sheffield Scientific School.

SCIENTIFIC NOTES AND NEWS

SIR ERNEST RUTHERFORD, Cavendish professor of experimental physics in the University of Cambridge, has been named as president of the British Association for the Advencement of Science for the annual meeting to be held at Liverpool next year.

A DINNER in honor of Dr. Mansfield Merriman, editor of the *American Civil Engineers' Handbook* and former professor of civil engineering at Lehigh University, is to be given by the New York alumni of that institution at the Aldine Club, New York City, on April 18. John R. Freeman, George H. Pegram, Robert Ridgway, Henry S. Jacoby, Frank P. McHibben and Ralph J. Fogg will be the speakers.

RAMON Y CAJAL will reach the retirement age on May 1, and a committee has been formed in Spain to organize a national demonstration showing the high regard in which he is held. An organizing committee has been appointed, the president of which is Dr. C. M. Cortezo, president of the Royal Academy of Medicine, and the secretary, Dr. C. Pittaluga. The plans of the committee include a special edition of Cajal's works, the construction of a monument and an increase in the appropriation allotted by the government for the maintenance of the Instituto Cajal.

SIR FRANK DYSON was elected president of the British Optical Society at the annual meeting held on February 9. At the same meeting Professor A. A. Michelson, of the University of Chicago, and Dr. M. von Rohr, of Messrs. Carl Zeiss, Jena, were elected honorary fellows of the society.

MR. G. V. COLCHESTER has been appointed to the post of geologist on the Geological Survey of the Anglo-Egyptian Sudan in succession to Mr. C. T. Madigan, who now holds a lectureship in geology at Adelaide University.

DR. CHARLES D. WOODS, who for nearly 25 years was director of the Maine Agricultural Experiment Station and more recently consultant in agriculture in the United States War Department, has accepted the directorship of the Division of Agricultural Information with the State Department of Agriculture of the Commonwealth of Massachusetts.

MR. C. S. BRINTON has been appointed chief of the Philadelphia Food and Drug Inspection Station of the Bureau of Chemistry, effective March 1, 1922. This appointment is made to fill the vacancy caused by the transfer of Mr. Arthur Stengel to the Bureau of Chemistry in Washington.

MR. D. D. BEROLZHEIMER, assistant technical editor of the Chemical Engineering Catalog and co-author of the Condensed Chemical Dictionary, has been appointed manager of the information bureau of the Chemical Catalog Company, Inc., and of the service department of the *Journal of Industrial and Engineering Chemistry*.

MR. ARTHUR D. HOLMES, who has been research chemist with the E. I. du Pont de

Nemours & Co. at the Jackson Laboratory, has resigned to accept a position with the E. L. Patch Company, Boston, Mass., to establish a research laboratory which will be concerned with investigations along biological and physiological lines.

DR. PERLEY SPAULDING, of the Bureau of Plant Industry, sailed on April 4 for Europe, where he will make a prolonged investigation of the white-pine blister rust. He will spend about eight months in Europe, covering the entire growing season, and visiting all parts except Spain, Russia and the Balkans. He will also represent the United States Department of Agriculture at the general assembly of the International Institute of Agriculture at Rome on May 8 to 18.

Nature reports that an expedition, consisting of Professor J. W. Gregory, of Glasgow University, and his son, Mr. Christopher J. Gregory, which has for its primary object the investigation of some features in the mountain structure of northwestern Yunnan and western Szechuan, expected to leave for Burma at the end of March. The area is one of special geological and biological interest. It includes some mountains of which the height varies, according to the available information, from 20,000 to 25,000 feet; and as these mountains occur in line with the Himalaya and the mountains south of Assam it has been suggested that they represent a prolongation of the Himalaya. Some zoological and botanical collections will be made which it is hoped will be worked out in the British Museum of Natural History and in the India Museum, Calcutta. The expedition will travel via Rangoon, and hopes to start from Bhamo, near the northwestern frontier of Burma, at the beginning of May.

WE learn from the *Journal* of the Washington Academy of Sciences that Secretary of Agriculture Wallace has appointed a committee of six scientific men from the department to consider the problem of land utilization. The committee consists of Messrs. L. C. Gray, of the Office of Farm Management and Farm Economics; C. V. Piper, of the Bureau of Plant Industry; G. M. Rommel, of the Bureau of Animal Industry; C. F. Marbut, of the Bureau of Soils; E. E. Carter, of the Forest Service; and S. H. McCory, of the Bureau of Public Roads.

GOVERNOR W. D. STEPHENS, of California, has appointed the following as a committee to investigate the agricultural colleges of the United States and report on a plan for improving the agricultural work of the state: G. H. Powell, Los Angeles; W. S. Guilford, Butte City; Elwood Mead, professor of rural institutions, University of California; James J. Hollister, Gaviota; Samuel G. Mortland, Fresno; Sheridan W. Baker, Santa Rosa, and R. G. Sproul, comptroller of the University of California.

ON the request of W. D. Bancroft, the National Research Council has appointed the following committee on theory of reactions of non-electrodes: Julius Stieglitz, of the University of Chicago, Roger F. Brunel, of Bryn Mawr College, H. S. Fry, of the University of Cincinnati, L. W. Jones, of Princeton University, James Kendall, of Columbia University, G. N. Lewis, of the University of California, and W. A. Noyes, of the University of Illinois.

THE National Canners' Association has just contributed to the University of Chicago $10,000 a year for two years for investigation into the causes of disease connected with their work. The investigation is to be under the direction of Professor Edwin Oakes Jordan, chairman of the department of hygiene and bacteriology, and will be in cooperation with the United States Public Health Service. Dr. J. C. Geiger has been detailed by the surgeon general of the United States to carry on this work under Professor Jordan, and for this purpose he has been appointed for two years to an associate professorship of epidemiology in the department of hygiene and bacteriology.

DR. F. W. ASTON, of the University of Cambridge, delivered an address on "Isotopes and the structure of the atom" before the joint meeting of the Washington Academy of Sciences, Philosophical Society of Washington and the Chemical Society of Washington, on March 29. Dr. Aston also gave lectures on March 30 and 31 before the North Carolina Chapter of the Society of Sigma Xi.

The Harben lectures will be given during the meeting at Plymouth of the Royal Institute of Public Health from May 31 to June 5 by Dr. T. Madsen, director of the State Serum Institute, Copenhagen.

The death is announced of Professor V. I. Palladin, the well-known plant physiologist, at the age of 63 years. Palladin published many scientific contributions, notably on the fundamental molecular phenomena of respiration. An English translation of his text book of plant physiology is used in many American universities.

Jules Schevitz, secretary of the Oklahoma Public Health Association, died on March 22, 1922, at the age of twenty-four years. A correspondent writes: "During the four years of his association with the work, he built up a statewide organization for the promotion of the public health, established tuberculosis dispensaries, initiated infant and child welfare activities, conducted a state-wide public health survey of urban conditions and succeeded in getting legislative action for the construction of three tuberculosis sanatoria."

The Pacific Division of the American Phytopathological Society will meet in Salt Lake City, Utah, from June 22 to 24, in conjunction with the summer session of the American Association for the Advancement of Science. It is hoped that any members of the parent society who are contemplating a trip to the Rocky Mountains or the Pacific Coast will arrange to be at Salt Lake for this meeting. Those who wish to present papers should notify S. M. Zeller, secretary-treasurer, Pacific Division, American Phytopathological Society, Oregon Agricultural College, Corvallis, Oregon.

The fourth annual meeting of the American Society of Mammalogists will be held in New York City from May 16 to 18. The sessions on the first two days, May 16-17, will be devoted to the reading of papers, discussion and business, and will be held from 10 A.M. to 4:30 P.M. in the American Museum of Natural History. A session will also be arranged for the evening of May 17. On May 18 the society will visit the New York Zoological Park as the guest of the New York Zoological Society. Headquarters will be at the Hotel Majestic, 72d Street and Central Park West.

The second national convention on commercial engineering called by the United States commissioner of education will be held on May 1 and 2 at the Carnegie Institute of Technology in Pittsburgh. Dr. Thomas S. Baker, acting president of the institute, has invited about 200 colleges in the United States and Canada to appoint delegates, many of which have already announced appointees. Invitations have also gone out from Washington to engineering professional societies, to individuals, and to more than 1,400 chambers of commerce and trade organizations. Dr. Glen Levin Swiggett, of the United States Bureau of Education, is chairman of the national committee, which includes prominent representatives of commerce and engineering interests throughout the country.

The National Committee on Mathematical Requirements announces that, owing to unfortunate delays in printing, its complete final report, "The Reorganization of Mathematics in Secondary Education," will not be ready for distribution before May, 1922. Requests for free copies of this 500 page report may be sent to J. W. Young, chairman, Hanover, New Hampshire. Owing to the labor and expense involved, the receipt of applications for copies of the report is not in general being individually acknowledged. Applicants may rest assured, however, that their requests will be filled when the report is ready for distribution.

The *Journal* of the American Medical Association reports that establishment in Washington, D. C., under permanent federal support of an institution where problems of disease and health may be attacked cooperatively along general chemical, physical, biologic, pharmacologic and other necessary lines, with the object of mastering these problems for the common good of humanity, are the proposals of a bill shortly to be introduced in the House of Representatives by Representative Roy O. Woodruff of Michigan. Dr. Woodruff is a physician as well as a dentist and he asserts that the practical advantage of such an insti-

tution was demonstrated during the World War by the existence of the American University experimental station.

THE Bureau of Foreign and Domestic Commerce, in cooperation with the Bureau of Mines, has completed arrangements to produce in this country motion picture films showing methods of production and employment of American machinery and similar products. The actual cost of the photography, as well as the expenses incurred in the making of additional prints of the films, is borne by the cooperating company. After the picture has been completed and approved, the work of distributing the films, both in this country and abroad, is taken care of by the Bureau of Foreign and Domestic Commerce without any further expense to the company.

FURTHER information in regard to radium in the Congo is quoted from the bulletin of the Belgian Chemical Society to the effect that the sample of minerals assayed by Professor Schoep of the University of Ghent yield 424 kg. of uranium and 139 mg. of radium to the ton. The minerals came from the Upper Katanga, in the concession of the Union Minière which has entrusted the industrial treatment of the uranium to the Belgian Société Générale Metallurgique de Hoboken, which has put up a factory for the purpose in the Antwerp district. Other deposits of the same minerals have been found at other points specified, and Professor Schoep has found two new kinds of minerals among them, extremely radioactive. He has named one "curite" and the other "kasolite," and announces that the crystals are soluble in nitric acid, and the radium salt can then be extracted from the fluid without passing through the usual calcination process.

IMPROVEMENTS of the wireless plant at the University of Iowa have increased the range of station 9YA to 1,000 miles under average conditions and 2,000 miles when conditions are favorable. The university is now broadcasting regular weekly programs under the direction of the extension division. Besides the regular programs all noteworthy happenings on the university schedule are broadcasted as they take place. Thus far nothing of a strictly educational nature has been attempted, the programs being arranged with entertainment rather than instruction in view.

DR. HENRY NORRIS RUSSELL, professor of astronomy, Princeton University; Dr. Robert A. Millikan, of Chicago, head of the Norman Bridge Laboratory, California Institute of Technology; Mr. Charles W. Brown, professor of geology, Brown University, and Dr. Gilbert N. Lewis, professor of physics, University of California, have completed a series of lectures at Pomona College, covering recent advances in physical science. Their subjects were: "The evolution of the stars," "Modern atomic theories," "The energy, composition and structure of the earth," and "The chemistry of the stars."

THE annual meeting of the Nebraska Academy of Science will be held at Nebraska Wesleyan University on April 21 and 22. On the evening of April 21 Dr. G. W. Stewart, of the University of Iowa will deliver an address on "Achievement in science." Weather permitting, this will be broadcasted by radio-phone. The annual address of the president, Professor J. C. Jensen, will be delivered at the general session on Saturday morning, the subject being "Recent research in atomic structure." In addition to a large number of papers, plans have been made for the showing of twelve reels of the finest scientific motion pictures available, and six or seven large manufacturers of scientific apparatus have agreed to send some of their latest models for exhibition.

At the regular meeting of the Biological Society of Washington, to be held on April 29, at 8 p.m., at the Cosmos Club, Washington, D. C., Dr. William E. Ritter, of the Scripps Institution for Biological Research, will address the society on "The usefulness and the peril of laboratory methods in biology."

UNIVERSITY AND EDUCATIONAL NOTES

MCPHERSON COLLEGE, McPherson, Kansas, is building a four story science hall modern in every way. The estimated cost is $160,000. It is expected to be completed by August.

A CONTRACT has been let for a new medical building at the University of Alabama, Tusca-

loosa, at a cost of $82,000. Construction work will be started immediately.

THE *Journal* of the American Medical Association states that the governor of Bengal laid the foundation stone of the new School of Tropical Medicine at Calcutta on February 14. The Indian government donated $195,000 for the site and will contribute toward the upkeep of the institution. Owing to the prevalence of tropical diseases in India, the work of the laboratory will be chiefly the investigation of causes of tropical diseases in an effort to discover more accurate methods of diagnosis and more advantageous process of treatment.

STEWART S. BRUCE, formerly professor of metallurgy and ore dressing at the Michigan College of Mines, is temporarily filling the chair of metallurgy at the University of Idaho, Professor R. B. Elder having a leave of absence on account of illness.

THE research chair of medical psychology in the University of Queensland, Brisbane, has been filled by the appointment of Dr. J. P. Lowson, university demonstrator in experimental psychology at the University of Cambridge.

DISCUSSION AND CORRESPONDENCE

OSBORN VERSUS BATESON ON EVOLUTION

PROFESSOR H. F. OSBORN'S challenge (this *Journal*, February 24, 1922) to Professor Bateson for his position on the evolution theory, ought to and probably will, make many a biologist gasp a little and wonder a good deal.

If one scans a bit thoughtfully the landscape of human life for the last few decades, he can hardly fail to see signs that the whole battle ground of evolution will have to be fought over again; this time not so much between scientists and theologians as among scientists themselves.

The purpose of this note is to put side-by-side two sentences, one from Bateson's Toronto address, the other from Osborn's challenge. Says Bateson: "Biological science has returned to its rightful place, investigation of the structure and properties of the concrete and visible world"; and Osborn: "If this opinion [Bateson's as to the failure of studies so far made to reveal the causes of the origin of species] is generally accepted as a fact or demonstrated truth, the way is open to search the causes of evolution along other lines of inquiry."

Of the many things that fairly beg to be said about both these sentences, this seems to me the most urgent: Why have biologists felt it so much more incumbent upon them to "search the causes" of the origin of the bodies which are subject matter of their science, than astronomers, and geographers and geologists have to search the causes of origin of the bodies they study?

Or, putting much the same question in another form: What would have been the effect on the sciences of astronomy, and geography, and geology, had their devotees given relatively as much time and energy to searching for causes as have evolutional biologists?

I doubt if any one acquainted however slightly with progress in the several domains mentioned would hesitate much for answers to these queries.

Undoubtedly those who investigate the heavenly bodies are interested, and deeply interested, in the causes which produced these bodies. And undoubtedly, too, all students of the earth want to discover the "causal factors" in earth production.

I venture here to be a trifle personal. Having been for years closely connected with investigations on the oceanography of the Pacific Ocean, I am greatly interested in oceanic causation. Indeed it would be a very great satisfaction could I contribute even indirectly and in the smallest way to discovering the causes of the Pacific Ocean.

But my oceanographic feeling has always been that "investigation of the structure and properties of the concrete and visible" greatest of oceans would be more fruitful than would search after the causes of it. Possibly I am wrong, but my guess is that the attitude of the great majority of modern astronomers, geographers, and geologists, toward their domains has resembled more my attitude toward

oceanic evolution than my attitude toward biological evolution when, twenty years ago I supposed, as Professor Osborn seems still to suppose, that search for causes of this latter evolution is the supreme goal of biological study.

But I am mindful that there is a reason why biologists have been goaded to strain themselves more in search of originating causes in their domain than have other scientists in search of such causes in their domains. That reason is the historic circumstance that these other scientists have long since been relieved of danger from the germ of supernatural causation in their domains, while this germ still lingers in the biological domain.

The way by which biology may escape limbo in this matter, Bateson, along with a considerable number of naturalistic biologists, is apparently beginning to see. "Meanwhile," he says, "our faith in evolution stands unshaken."

What is the lesson, practical and theoretical, implied in such a declaration? What it is for Bateson of course I do not know. For myself it is this: *Let us stop trying to convince ourselves and others that we have discovered, or in a few minutes will discover, the causes of evolution, and devote our efforts to perceiving for ourselves and convincing others of the naturalness, through-and-through, of evolution.* In other words, *let us bestow much more time and energy upon the grounds of our faith in evolution as one of nature's grandest processes, than upon searching after, and speculating about, the causes of evolution.*

WM. E. RITTER

UNIVERSITY OF CALIFORNIA,
SCRIPPS INSTITUTION FOR
BIOLOGICAL RESEARCH,
MARCH 4, 1922

FURTHER CONSIDERATION OF THE SIZE OF VEIN-ISLETS OF LEAVES AS AN AGE-DETERMINANT

IN a recent paper[1] regarding vein-islet measurements as a means of determining the age of the woody perennial upon which the leaves are borne, the use of fresh leaves under low magnification was criticised. The basis of the criticism was that different thicknesses of chlorophyll would affect the number of veinlets visible and thus affect the apparent size of the vein-islets. This of course, is true. The fact that it is true constitutes one of the important advantages of the method criticised and is an equally important objection to the *sole* use of the suggested method.

In my original paper it was pointed out that the palisade cells decreased in size with age as do all of the other kinds of cells in the leaf with the exception of the cells of the veinlets which increase somewhat in size. With increasing age both the lessening thickness of the chlorophyll-containing cells and the increasing size of the conducting cells will render the veinlets more conspicuous. The actual increase in the amount of conducting tissue in the leaf is emphasized by increased visibility. The use of fresh material under low magnification gives a morphological summation which the suggested method quite lacks and therefore I adopted it after a trial of both. In this case the method adapted to field use is the more precise, as an age-determiner.

As is well known, the venation of the leaf of any given species is affected by external agents. Different species respond to these factors in different ways. Since the size of the vein-islets is affected by these factors, a successful use of this method of age determination requires sufficient familiarity with the responses of the species used, to enable one to eliminate the differences not due to age. As soon as this is done the relation of the size of the vein-islets to age is clear.

Since the discovery that the "protoplasm" of plants was fundamentally the same as the "sarcode" of animals, the progress of physiology has been steadily toward a demonstration that in the essentials of composition and response the two are essentially alike. Any theory of senility which can not be applied to plant conditions is not a fundamental theory and can be disregarded. It is equally true that any characteristic so strongly marked as

[1] Ensign, M. R., Area of vein-islets in leaves of certain plants as an age determinant, *Jour. Bot.*, 8: 433, 1921.

is the process of senility in the animal can not be unrepresented in the plant world.

Harris M. Benedict
University of Cincinnati

THE METRIC SYSTEM

Referring to the article, "Progress in Metric Standardization," by Professor Bingham in your impression for March 3, it seems impossible to make the metric party understand that while, in some applications, the adoption of the metric system is easy, in others it is supremely difficult. It has been shown repeatedly that the easiest of all units to change are those of capacity and that the easiest of all places in which to adopt the system is the scientific laboratory, and the metric argument is that, these changes being easy, therefore all others are easy, when the fact is that others are so difficult that they have not been brought about in any country in the world, the net result being a dual or mixed system to which the arguments advanced for the metric system have no application.

Your readers should obtain the recent Report of the National Industrial Conference Board on this subject, which is the result of an investigation that consumed a year and is the most exhaustive that has ever been made and which confirms *all* of our contentions. Moreover, the Report is signed, without reservation, by two members of the Council of the American Metric Association who, the facts being established, signed it because they could not do otherwise.

Within a year a committee of the Conjoint Board of Scientific Societies of Great Britain, representing forty-nine scientific societies, representing, in turn, every conceivable phase of scientific activity, have made a unanimous report recommending that the metric system be *not* adopted in Great Britain.

Moreover, these are but examples. During the past century seven investigations worthy of that name have been made in this country and Great Britain, the result of every one being adverse to the claims made for the system. The plain fact is that the metric party always lose when both sides are heard, the most recent example being at the late convention of the Chamber of Commerce of the United States of America.

The weakness of the metric party today lies in their refusal to read the anti metric case. Because of this, their representatives went before the Senate Committee on Manufactures during the past winter at Washington and repeated claims that were disproven twenty years ago. The case was thus made extremely easy for the opposition, as we had only to point out the facts in order to show not only that the metric party had no case, but also to discredit their witnesses as incompetent.

There is no better illustration of this failure to acquaint themselves with the facts than Professor Bingham's naive assumption that the opposition is composed of "a few gage manufacturers."

It is interesting to note that, after we have been assured for many years that the system is "universal" in Chemistry, you are now inaugurating a campaign to bring about its use by chemical manufacturers.

Frederick A. Halsey,
Commissioner of the American Institute of Weights and Measures

This letter is suggested by Mr. Eugene C. Bingham's article on "Progress of Metric Standardization" in the March 3 number.

I am an ardent advocate of the metric system, and feel that one of the greatest difficulties in bringing it into general use has been our prolonged period of consideration, during which many of us have been really working with two systems, and have borne all the burdens which that condition imposes.

The Drug Trade and Pharmacy generally has probably gone as far in the change as any other commercial group, but if the system were made compulsory there would be a large number of changes, some requiring an act of Congress. For example, that requiring that certain medicines bear the content of certain drugs—Opium, in grains per fluid ounce.

For the transition period certain comparative tables will be necessary—a comparative table showing prices in dollars and cents per Avoirdupois pound or ounce equals dollars and cents per kilo or grams.

The Bureau of Standards recently advised me that they did not know of any such publication, yet it seems that this would be one of the first requirements for a commercial change, and if it were now provided, might clear the way for the next step. The willingness of certain chemical manufacturers and dealers to furnish goods in metric quantities, does not amount to very much—it is easily done, and has been done automatically since the demand appeared, but a few more practical suggestions with the necessary tools (such as conversion tables as above) would greatly smooth the way in the eyes of the average business man, who is probably accounted the greatest opponent of the change.

HENRY PAUL BUSCH

CONCERNING THE ARTICLE "A NEW GRAPHIC ANALYTIC METHOD

IN an article entitled, "A New Graphic Analytic Method," in SCIENCE of October 7, 1921, Mr. R. von Huhn states a method of deriving the graph of a special case of a function of a function. Stated in more usual mathematical terms:

Given the curves that represent

$$y = kx + m,$$
$$z = hy + n,$$

the curve that represents the resulting equation

$$z = lx + q$$

is drawn.

Essentially the same method, in a far more general form, and in a more usual mathematical formulation has been given by several mathematicians. See the articles by E. H. Moore, "Cross-section paper as a mathematical instrument," in *The School Review*, May, 1906, and by A. Kempner, "Some hints on plotting graphs in analytic geometry," in *The American Mathematical Monthly*, Vol. XXIV, pp. 17-21, and, in particular, the more specific article by W. H. Roever, "Graphical constructions for a function of a function and for a function given by a pair of parametric equations," in *"The American Mathematical Monthly*, Vol. XXIII, pp. 330-333. E. R. Hedrick has suggested the modification of transferring points from one of the two like-named axes to the other by means of a 45° triangle and he has also emphasized the geometric interpretation of the operation as that of finding the projection on the plane xy of the intersection of the two cylindrical surfaces

$$F(x, y) = 0, \qquad \Phi(y, z) = 0$$

This perfectly general problem was well-known to mathematicians and hence the special case treated in the article mentioned above can not be regarded as novel.

WM. H. ROEVER
E. R. HEDRICK

WASHINGTON UNIVERSITY

SPECIAL ARTICLES

THE PROPERTIES OF ELEMENTS AND SALTS AS RELATED TO THE DIMENSIONS OF ATOMS AND IONS[1]

(An Application of Geometry to the Study of Inorganic Chemistry)

RECENTLY great interest has been aroused in connection with the determination of the dimensions of atoms and ions by various methods; particularly that of X-ray crystal analysis,—by Bragg, Landè, Hull, Davey, and others. Very recently Fajans and Grimm, and later Biltz and also Henglein have pointed out that there is a very simple linear relation between the volume of certain series of salts and the atomic volumes of their constituents. Six years ago Professor W. D. Harkins and the writer began work upon what are known as complex chemical compounds, such as ammines and hydrates, in an attempt to show *that a large number of the properties of these compounds, as well as those of simple salts, are very simply related to the sizes of the atoms, atomic groups, and ions, from which the salts are built.* This point of view has now been developed in considerable detail by the writer. *The simplicity of the relation is apparent when it is realized that for a number of groups in the periodic system of the most common elements, as many as 35 properties of their simple compounds have been found to be related in a linear way to the atomic and ionic volumes of*

[1] From an address presented at the University of Chicago in December, 1921, and to the Harvard-Technology Chemical Club in January, 1922.

their constituents, as will be shown later in detail.

The present paper will be limited to a consideration of these relationships in the case of the elements and simple compounds, and will indicate briefly some of the most interesting of a large number of cases which show the above simple relationship.

While the writer was working upon the more extended and general set of relations given in this letter, the above mentioned paper by Biltz appeared. In this he exhibited the volume relations which may be used as a basis for the general discussion. Biltz found that if the atomic volumes of certain of the noble gases (argon, krypton, and xenon) are plotted along one axis in a two dimensional plot, the atomic volumes of the three corresponding halogens give one straight line, the three alkalies another, the three members of group 4B another, and the three members of group 4A, a fourth straight line; while in all of the other groups there is a departure from linearity. It may be noted that the alkali and halogen groups on the one hand, and groups 4 A and B on the other, are equidistant from the group of the rare gases of the atmosphere in the periodic table of the elements as represented by Harkins and Hall. The facts found in this work are beautifully in accord with what might be expected from this particular model of the periodic system.

The relations found by the writer are much more general than those given in the preceding paragraph. *Thus it is found that if the atomic volumes of the five alkali elements are plotted on one axis* (as the X-axis) *of a three dimensional rectangular coordinate system the atomic volumes of the four halogens on the Z-axis, and the molecular volumes of the alkali halides on the Y-axis, practically all of the points* (*all except some of those for cæsium*), *lie quite nearly on a plane* $z = bx + cy + d$ *which passes nearly through the origin.* Thus the relationship is very much more simple than has heretofore been suspected.

It is even more remarkable that when instead of the molecular volumes of the salts, other properties are plotted on the Y-axis, it is found that *in a very large number of cases* the surface, while not a plane, is of the extremely simple form known as a *doubly ruled surface.* Commonly the surfaces found may be expressed by the equation $z = axy + bx + cy + d$. For the molecular volumes of the alkali halides, the following expression, in which z is the molecular volume, x the atomic volume of an alkali metal, and y the atomic volume of a halogen, holds rigorously: $z = .0074xy + .3655x + y - 9.07 = .00849xy + .3345x + .9442y - 7.49$.

Since it is difficult to present the characteristics of these remarkable doubly ruled surfaces in a very simple way, the discussion of the present paper will be given in terms of the projections of these surfaces on the various coordinate planes. Simply to present one example, the two dimensional plot for the halogens may be considered. If the atomic volumes of the four members of the halogen group, fluorine, chlorine, bromine, and iodine, are plotted along one axis of a plane rectangular coordinate system, and along the other any of a large number of properties of other groups of elements, of other properties of the halogens themselves, and of compounds in which they are substituents, perfectly linear relationships are found, for which simple equations may be derived and calculations made with which reputable experimental data agree quite accurately. Some of these properties linear to the *halogen atom dimensions* may be briefly enumerated as follows: atomic volumes, atomic radii, viscosities or boiling points of the rare gases; atomic volumes of the alkali metals and alternate members of group 4; *for the elementary halogens,* the molecular diameters, melting points, boiling points, critical temperatures, latent heats of fusion and vaporization, normal potentials, cubical coefficients of expansion, atomic frequencies, magnetic susceptibilities, cohesional dimensions, $\sqrt{a}$ and b of van der Waals' equation, and the heat of formation of ions from the elements; *for the hydrogen halides,* the molecular volumes and diameters, boiling points, melting points, critical temperatures, latent heat of vaporization and the energy of ionization; *for organic compounds,* the atomic volumes of the halogens in combination, the atomic refraction for the D

TABLE I.
Atomic and Ionic Radii ($\times 10^8$) for the Halogens.

	Bragg[2]	Davey[3]	Rankine[4]	Landè[5]	Grimm[5]	Schwenden-wein[5]	Richards[6]	Henglein[7]
F–		1.13			0.75	0.99		0.8525
Cl–	1.06	1.56	1.27	1.60	0.95	1.232	1.40	1.00
Br–	1.19	1.73	1.35	1.80	1.02	1.312	1.55	1.066
I–	1.40	1.98	1.49	2.10	1.12	1.432	1.70	1.179

line, and the molecular volumes of numerous halogen-substituted compounds; *for salts,* the molecular volumes of practically all metal halides, the volume change in solution, the melting points, boiling points, latent heat of vaporization, heat of formation and specific compressibilities of the alkali halides and many others, the percentage contraction for halides of small cations, the distance between the centers of oppositely charged ions in crystals, and the radii of ionic halogens.

There are many interesting details of each item in the above enumeration of which space does not admit detailed consideration. For example the percentage contraction undergone when a salt is formed from the free elements, is found in this work to be related in a *fundamental* way to the *properties of the complex compound* formed from it. Thus when a nickel halide is formed by the union of nickel with any of the halogens (fluorine, chlorine, bromine, or iodine) the percentage contraction is the same (22.5 per cent.) in each of the four cases. In the case of the cobalt and cupric halides the magnitude of the contraction is not quite constant, but increases slightly from the fluoride to the iodide. The constancy of the percentage contraction is also found when any halogen is combined in turn with the alkali metals (lithium, sodium, potassium, and rubidium). The contraction amounts to 60 per cent. each for the four fluorides, 43 per cent. each for the four chlorides, 38 per cent. each for the four bromides, and 30 per cent. for the four iodides. It is seen that the relative contraction decreases with increasing number of non-nuclear electrons in the halogen atom. The contraction for the cæsium halides is greater than that given above for the other alkali halides. However in the oxy-acid salts cæsium shows the same contraction as the other salts of the alkalis, and in *molten halides* it is also *perfectly normal* as indicated by the careful researches of Jaeger. The anomaly of cæsium is therefore to be attributed to difference in crystal form. As a matter of fact cæsium halides possess cube-centered lattices, while all other alkali halides are simple cubic.

The ionic radii can be derived from experimentally determined crystal distances only by means of some assumption. The following table shows the widely varying values, multiplied by 10^8, which have been presented by eight workers.

It is a *singular fact that in spite of the wide discrepancies all of the values except those of Richards are quite accurately linearly related to the atomic volumes of the halogens at the boiling point,* showing that whatever basis of calculation may be the closely similar halogens are still related to each other in relatively the same way. Richards' values are calculated from the atomic volumes of chlorine, bromine and iodine at 25° where the three values are practically coincident, and this may explain the deviations in this case. However the *third powers* of the radii values, as direct functions of the volumes of single combined atoms, are found to be linearly related to gram-atomic volumes. This is apparently of greater signifi-

[2] From close-packing in crystals.

[3] From equality in size of ions with same number of external electrons: $K^+ = Cl^-$, $Rb^+ = Br^-$, $Cs^+ = I^-$.

[4] From viscosity of gaseous halogens, hence radii of atoms.

[5] From various aspects of Bohr theory. Represents actual distance from nucleus to outermost electron orbit.

[6] From extrapolation of compressibility-contraction curve to zero compressibility.

[7] From empirical considerations of linearity to molecular volumes, *Zeit. anorg. allgem. Chem.*, 120: 77 (December 14, 1921).

TABLE II
Atomic and Ionic Radii ($\times 10^8$) of the Alkali Elements[10]

	Bragg	Davey	Landè	Grimm	Schwenden-wein	Richards			Saha[9]	Heng-lein
						Chloride	Bromide	Iodide		
Li	1.50	0.98	0.88		0.50	1.15	1.20	1.30	1.34	1.00
Na	1.75	1.25	1.15	0.52	0.65	1.45	1.45	1.55	1.41	1.428
K	2.10	1.56	1.45	0.79	0.948	1.75	1.75	1.85	1.67	2.108
Rb	2.25	1.73	1.60	0.91	1.128	1.90	1.90	1.95	1.73	2.478
Cs	2.35	1.78	1.60	1.01	1.32	1.90	1.85	1.90	1.86	

cance that the chance linearity of *first powers*. The most recent values are those of Henglein, whose procedure is very questionable inasmuch as he takes Fajans' values for bromide and iodide ions and then *assigns values* to chloride and fluoride so that a straight line connects the molecular volumes of the halides of any alkali metal and the sizes of the substituent halogen ion. By using the same process for determining the sizes of the alkali ions it is of course possible at once to write an equation by which the molecular volumes may be calculated from the *constant size* of the ion. Henglein quite naturally observes a very good agreement between calculated and experimental values.

Table I indicates the definite progression in size and properties from one member to the next in such nearly perfect[8] families (or groups) of elements as the halogens and the alkalies.

It is interesting in this connection to compare the radius of the ammonium ion. Using the distance between ion centers found by Bartlett and Langmuir for the ammonium halides, and subtracting the radii of the halogen ions, the ammonium ion is found to have a radius of 1.90×10^{-8} cm., if Richards' values are used, or 1.76×10^{-8} with Davey's. In either case this is also the radius of the rubidium ion. That this equality is extended to the molecular volumes and other properties of both simple and complex ammonium and rubidium salts may be shown by numerous examples.

From the above considerations it is at once apparent that, by plotting the various properties of the halogens, *both free and combined*, which are linear to the dimensions of the halogens, a large number of possible new linear relationships may be predicted. It has never before been possible to ascribe such perfect and simple constancy and dependency of essentially all properties upon one fundamental variable of matter. The definite increase in size in passing from fluorine to chlorine to bromine to iodine atoms is paralleled in a linear fashion not only by all dimensions of the atom free or in combination, neutral or charged, but by practically every measurable property. That this extends even to variations in the electromagnetic stray fields which determine the strength of secondary valence forces and complex salt formation, will be indicated in a following paper.

Exactly as has been done with the halogens, the various properties of the alkali metals, free and combined, may be related. The ionic radii have been variously calculated as follows: These values (with the exception of those of

[8] According to the periodic table of Harkins and Hall the two groups of elements nearest the group of rare gases, that is the alkali and halogen groups, should be the ones in which linear relations may be expected to hold for practically all of the elements in the group. Such groups may be designated as "perfect." In this sense groups 2 to 6 inclusive are imperfect, since a considerable break in properties occurs between the second and third elements in each of these groups.

[9] From ionization potentials.

[10] Other values are those of Born from heats of hydration, Pleyer-Wegau from diffusion of metals in mercury, Stokes-Born from ion mobilities, Gunther-Schulze from volume changes in permutites and from polarization capacities, and Heydweiller from ion refraction.

Richards) are related in a linear way to many of the properties of the elements and their salts.

From the average of the most logical values of the effective radii of atoms and ions of the alkali metals and the halogens it is found that the space functions of the third powers of the radii are as follows: for halogen ions, φ_0 (ratio of cube of radii $\times$ 6.063 $\times$ 10^{23} to gram-ionic volume) = .44; for halogen atoms, φ_0 = .25 (agreeing with van der Waal's postulate); for alkali ions, φ_0 = .25; and for alkali atoms, φ_0 = .52. In other words the volume of the halogen ion is roughly 44-25 that of the atom, and the alkali ion 25-52 of the corresponding atom. Upon this simple basis the molecular volumes of the alkali halides are found to be dependent as $3.35 \times 10^{24}(r^3_{\text{hal·ion}} + 1.76r^3_{\text{alk·ion}})$.

Finally there are many linear relationships to be found among the other elements: *e. g.*, the molecular volumes of the cuprous, silver and thallous halides and the *stability of the triammines* of these halides, to the atomic volumes or ionic sizes of cuprous copper, silver and thallium; the atomic volumes of calcium, strontium and barium (in some cases also lead), to the molecular volumes of practically any alkaline earth salt, or the stability of the hexammines of the metals (*e. g.*, Ca. 6 NH_3) to the ionic sizes of the alkaline earths; the molecular volumes of various sulfides, selenides and tellurides to the size of sulfide, selenide and telluride ions; the molecular volumes of the oxides to the atomic volumes of titanium, zirconium and cerium; and numerous linear relationships between the molecular volumes, stability, percentage contraction and heats of dissociation of complex compounds and the molecular, atomic and ionic dimensions of the constituents of the whole complex molecule. These will be considered in a separate paper.

The general method of representing the properties of salts as functions of the dimensions of their constituent ions (or of the atomic volumes of the constituent elements) is of such fundamental importance that an extensive study of the characteristics of these surfaces is now being made in collaboration with Professor A. C. Lunn and Professor W. D. Harkins of this university. As has been stated some of these *surfaces* are *planes,* while most of the others are *doubly* ruled.

GEORGE L. CLARK
UNIVERSITY OF CHICAGO,
FEBRUARY 3

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION L (1) HISTORY OF SCIENCE

THE History of Science section was organized on a temporary basis at the Chicago meeting of the American Association for the Advancement of Science, December, 1920. At the Toronto meeting, December, 1921, it was formally organized, and recognized by the Council of the American Association for the Advancement of Science as a sub-section in Section L (Historical and Philological)

This step now assures the future of the History of Science movement in the United States. The movement has been growing steadily, not alone in active interest and research by various scholars, but by the fact that our colleges, universities and technical schools are taking cognizance of its place in the curriculum of science and technology.

If we are, at all, to enter a new epoch of science teaching, and give more emphasis to the humanistic element in our sciences, it is evidently time now to consider the matter. Science, that which we love to call pure science, has been too long dominated by the ulterior motive of materialism.

The fact that the American Association for the Advancement of Science has recognized the value and purpose of History of Science, and accorded it a place in its comprehensive activities, indicates a step forward, not alone in the "Association" progress, but in science, and in educational methods as well.

A movement that can be fostered by two large and widely different organizations, such as the American Historical Association and the American Association for the Advancement of Science, is doubly assured of success and future stability, in relation to other intellectual movements.

The Toronto meeting was in charge of a local

committee, Dr. J. Playfair McMurrich and Dr. G. S. Brett, appointed by Dr. Burton E. Livingston, permanent secretary. To this committee great credit is due for the courtesies shown, in the matter of room selection and accommodations, lanterns, etc.

The program committee adhered to the policy adopted last year, by extending invitations to representative scholars to present papers, each paper illustrative of research in the field of some particular historical problem—technical and cultural.

The meeting was called to order by Dr. William A. Locy, chairman of the interim committee, Dr. Walter Libby acting as secretary *pro tempore*. The first paper on the program, "Leonardo da Vinci—Artist or Anatomist?" was given by Dr. J. Playfair McMurrich, of the department of anatomy, University of Toronto. Dr. McMurrich proved by reference to Leonardo's masters that Leonardo's initial interest in anatomy was that of the scientific artist. In discussing the address of Dr. McMurrich it was suggested that there was an analogy between the relation of Leonardo to the science of anatomy and the relation of Shakespeare to the science of psychology. In answer to a question, Dr. McMurrich expressed the view that Leonardo did not anticipate Harvey's discovery of the circulation of the blood. Continuing, Dr. McMurrich further remarked:

"Attention was called to the rapid improvement in anatomical illustration in the first half of the sixteenth century after a prolonged reign of crude conventionalism, and the attempt was made to connect this with the art renaissance which preceded that of science. The endeavors of the artists of the Renaissance to delineate accurately the human form led to better standards of observation, without which accurate drawing was impossible, and this reacted on the anatomists.

The great interest of the fifteenth century artists such as Pollajuolo, Verrocchio and Michelangelo in anatomy was noted and it was pointed out how great was the probability that Leonardo received his initiation into anatomical studies during his apprenticeship to Verrocchio. He approached anatomy from the standpoint of the artist, but his genius quickly led him to inquiries into the conditions underlying and determining surface form, and the artist became an anatomist.

The second paper was by Dr. Walter Libby, of the University of Pittsburgh, "History as the Record of Human Possessions." Dr. Libby pointed out the value of taking stock of the paraphernalia of civilization—such as metals, buildings, books, musical instruments, machines—in the succeeding historical epochs. A study of cultural equipment enables one to view the history of the race as a progressive development. The Greeks passed from barbarism to the highest civilization when they came in contact with the cultured accumulations of the Egyptians, Babylonians and Cretans. Similarly, the Arabs ceased to be a rude, uncivilized people only when they gained possession of the books, buildings, etc., of the Mediterranean basin and of Mesopotamia.

Dr. William A. Locy, Northwestern University, followed with the third paper entitled "The *Hortus Sanitatis* (1491) and Related Books." Dr. Locy's address was splendidly illustrated. He not only used the lantern to show pictures of plants and animals taken from the *Hortus Sanitatis* of 1491 and similar works, but he displayed photostat reproductions of selected pages of this famous work.

"The *Hortus Sanitatis* is a famous knowledge book on natural history and popular medicine, printed for the first time in 1491 and in many editions thereafter. It was widely circulated and of immense popularity. It appeared in that interesting period of intellectual development just preceding the full bloom of the Renaissance and it throws light upon the rebirth of the scientific attitude of mind. Representing a phase in the struggle of the human spirit to get away from the mystical and subjective method of thinking, which had prevailed for centuries, it is an important human document and is not to be looked on as merely a curiosity of antiquarian interest. A mental revolution was coming on, destined in the following half-century to establish observation in place of dependence on authority as a method of advancing knowledge, and books like the *Hortus Sanitatis* were harbingers of this revolution.

"Other related books such as the *Book of*

Nature, printed in 1475, and the *Garten der Gesundheit,* especially since the *Garten der Gesundheit* of 1485 is of higher quality, and some of its illustrations represent the earliest printed pictures of animals and plants drawn from nature. The publication of these sketches in 1485 'forms an important landmark in the history of botanical illustration, and marks perhaps the greatest single step ever made in that art.' They were unequaled until the publication of the herbals of Brunfels and of Fuchs half a century later. The *Hortus Sanitatis* was more widely distributed, and since it was a larger and later production, generally it has been assumed that it contained the best pictures of the period—but this is wrong. The much rarer *Garten der Gesundheit* of 1485 (often confused with the *Hortus Sanitatis*) is the only member of that family of books which has excellent pictures drawn from nature.

"As a publisher's venture in the early days of printing, the preface of the *Hortus Sanitatis* contains a clever appeal to the commercial instinct, saying, that by help of the information contained in the book, people 'with quite small expense to themselves will be able to compound helpful remedies and perfect medicines' without the necessity of doctors and apothecaries. Another feature of the book, however, had greater influence on the thought of the time: through its 1,066 pictures and descriptions attention was directed to the productions of nature and information was spread regarding plants, animals and minerals. Almost the whole structure of modern science rests on such humble beginnings."

Dr. G. S. Brett, of the department of philosophy, University of Toronto, presented an unusually interesting paper in that it gives the philosopher's point of view in the history of science, "The Theory of History in Relation to the History of Science." Dr. Brett also discussed the idea of the history of science and the difficulties that lie in the way of making history of science a branch of academic instruction.

This paper was presented as a contribution to the problems of method. Reference was made to the status of the Section and to recent discussions on the subject, especially to the paper by Professor E. H. Johnson, contributed to SCIENCE December 16, 1921. The writer argues that the difficulty of finding a place for history of science in a curriculum was partly due to a want of clear ideas on the nature of the subject. This point was further explained by a sketch of the development of historiography, which was shown to be dependent on a variety of interests. The early tendency to comprehensive records gave place to a more restricted aim which virtually made history equivalent to political annals. The idea of progress brought to light the idea of continuous historical development, and led to a philosophy of history which attempted to organize the facts as proof of the theory. This failed because the actual historical sequence did not conform to the theories, as for example the attempts of the Romantic school to demonstrate a rational solution. After tracing the tendency in modern historical work to break new ground in the history of literature, the history of general types, such as "federation" or "liberty," and even the "history of historians," the writer argued that a specified type of history was required for the history of science. In its essential feature, this would not be identical with biographical work on men of science, or with the type of work which naturally forms the background of any particular study. While monographs on these subjects are indispensable preliminaries, a good history of science must coordinate the achievements with the total conditions, social and intellectual, which culminate in them. It was argued that in this field there is a unique opportunity for studying the cumulative growth of culture, and for exhibiting the way in which ideas persist and are transformed. The lack of a sufficient literature, neither sporadic nor biased by national interests nor disproportionate in the treatment of topics, makes the subject difficult to teach. It was also the best proof that the nature of the subject was not properly understood.

In the absence of the next speaker and the secretary, the following paper was read by title only: "Historical Basis for the Scientific Stagnation of the Middle Ages," by Dr. Harry E. Barnes, of the department of the history of thought and culture, Clark University, Worcester, Massachusetts.